SVKM's
D. J. Sanghvi College of Engineering

Program: B.Tech in Mechanical Engineering **Academic Year: 2022** **Duration: 3 hours**
Date: 21.01.2023
Time: 09:00 am to 12:00 pm
Subject: Engineering Thermodynamics (Semester III) **Marks: 75**

(1) This question paper contains two pages.
(2) All Questions are Compulsory.
(3) All questions carry equal marks.
(4) Answer to each new question is to be started on a fresh page.
(5) Figures in the brackets on the right indicate full marks.
(6) Assume suitable data wherever required, but justify it.
(7) Draw the neat-labelled diagrams, wherever necessary.
(8) Use of Mollier chart, steam table is permitted.

Question No.			Max. Marks
Q1 (a)	i.	One kg of air is at 1 bar and 300 K is compressed adiabatically till its pressure becomes 5 times the original pressure. Then it is expanded at constant pressure and finally cooled at constant volume to return to its original conditions. Calculate Heat transfer, and internal energy for each process.	[07]
		OR	
	ii.	75 kg/min of air enters the steady flow device at 2 bar and 373 K at an elevation of 100 m above the datum. The mass leaves the device at 150 m elevation from datum at pressure of 10 bar and at a temperature of 573 K. The entry velocity is 40 m/s and exit velocity is 20 m/s. During the process 54000 kJ/hr of heat is added to the system and increase in enthalpy is 8 kJ/kg. Calculate power.	[07]
Q1 (b)	i.	Explain Quasistatic process.	[05]
	ii.	Differentiate between adiabatic and polytropic process.	[03]
Q2 (a)	i.	Write statements of second law of thermodynamics and prove their equivalence.	[06]
		OR	
	ii.	State and prove Carnot theorem.	[06]
Q2 (b)	A heat engine operating between two reservoirs at 1000 K and 300 K is used to drive a heat pump which extracts heat from the reservoir at 300 K at a rate twice that at which the engine rejects heat to it. If the efficiency of the engine is 40 % of the maximum possible and the COP of the heat pump is 50 % of the maximum possible what is the temperature of the reservoir to which the heat pump rejects heat? What is the rate of heat rejection from the heat pump if the rate of heat supply to the engine is 50 kJ/s.		[09]

Q3 (a)	i. Derive an expression for efficiency of air standard Otto cycle. ii. Compare Otto diesel and Dual cycle for same compression ratio.	[06] [03]
Q3 (b)	i. Steam of 500 kPa having dryness fraction of 0.9 expands adiabatically and reversibly to a final pressure of 100 kPa. Find its final condition. **OR** ii. In a Rankine cycle, the steam at inlet to a turbine is dry saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. Calculate a) Rankine efficiency b) Turbine work, if mass flow rate is 5 kg/s.	[06] [06]
Q4 (a)	An engine operates on air standard diesel cycle. The pressure and temperature at the beginning of compression are 100 kPa and 300 K. The compression ratio is 18. The heat added in the cycle is 1850 kJ. Find Maximum pressure, maximum temperature, thermal efficiency. Consider mass of air = 1 kg.	[09]
Q4 (b)	i. Derive an expression for Work for a single acting compressor without clearance. **OR** ii. Derive an expression for Volumetric efficiency of compressor in terms of clearance ratio.	[06] [06]
Q5 (a)	**Write short note on (any two).** i. Maxwell equations. ii. Multistage Compression. iii. Clausius Clapeyron equation. iv. Available and Unavailable energy.	 [05] [05] [05] [05]
Q5 (b)	Prove that entropy is a property of the system.	[05]